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AUSTRALIAN EUCALYPTUS TIMBERS

1. **Historical. -** As shewn by early records, the first conception of the utility of Australian eucalyptus timbers was not at all satisfactory or complimentary, for a certain Major of Engineers in a letter home, containing his impressions of the newly occupied country, writes very disparagingly of matters generally, and particularises the timber resources of Australia as practically **nil**, for he states in this connection, "even the trees (Eucalyptus) are worthless, for not only after they fall, but even whilst standing they are turned into **sand**."

Australians, of course, quite understand the reason for this statement, and it is interesting to compare it with the generally accepted verdict today - that in regard to hardwoods and decorative timbers the Australian eucalyptus holds its own in the timber markets of the world.

In the early days of Colonial history, when freights were of course scarce, evidence shews that eucalyptus timber was one of the first raw products to be exported to England, where it was used in the Naval dockyards for ship building.

The value of these timbers has from time to time been brought under the notice of the outside world by the collections exhibited at the various exhibitions held in London in 1851 and l862, and in Paris and other International Exhibition centres.

As population grew, and trade increased, more attention was paid to timber resources; the early researches of Col. Ward Laslett, and more recently those of Professor Warren and G. A. Julius, adding considerably to our knowledge.

The early nomenclature applied to the various eucalyptus species was, naturally, imperfect, and while it possesses a certain value, nevertheless it renders the task of comparison with modern results a somewhat laborious one.

2. **Nomenclature.** - The vernacular naming of the eucalyptus trees has unfortunately been one of the bugbears of the Australian trade since its inception. The prime cause of the trouble was the giving of common English names to Australian trees, having a fancied or supposed resemblance to the English product. This practice was frequently responsible for the most ludicrous results. For example, the name "Apple tree" was applied to some species of eucalyptus which have absolutely nothing in common with their English namesake. Many similar instances could be given. Again, the same common name is sometimes bestowed upon half-a-dozen different species.

As the result of concerted action on the part of the respective State Forestry Departments, immediate action is, however, to be taken to introduce order into the present chaos.

There is, moreover, such a wealth of timber in Australia, that there are not enough common names amongst those so far used to cover each species. This difficulty could, nevertheless, be overcome, by employing the specific portion of the scientific names as trade terms. Objection would of course be raised that business people could not use these names, but this objection may be countered by pointing out that in connection with the trade in the essential oils of the eucalyptus no difficulty has been experienced in regard to the adoption of the correct scientific appellation.

The Technological Museum, by suppressing the common name and species synonyms, and using scientific names only from the start, has assisted the perfumery, pharmaceutical and other industrial enterprises in overcoming the difficulty, so that today all these various industries give orders for oils under the scientific names, and will have nothing to do with the common names. A guarantee is thus assured of the true origin of the article which is being purchased. It is really remarkable how quickly Australian bushmen familiarise themselves with the scientific terms, and there is hardly a distillery working in Australia today, either in the city or the "back blocks," where the worker cannot give the scientific names of the leaves being distilled.

Contributed by R. T. Baker, Esquire, F.L.S., etc., Curator and Econ. Botanist, Technological Museum: Lecturer on Timbers, Sydney University.

Further, since no one is allowed to sell margarine for butter, a customer ordering ironbark should not be supplied with a timber that is not an ironbark, but really a mountain ash, the former name being applied only in one particular State, and that, where the true ironbark does not grow.

The subject of nomenclature is mentioned because it is of the very greatest importance in the timber export trade, and also because serious attention is being given to it by the respective State Forestry Departments. who look to the co-operation of the timber trade to assist in the removal of so serious a handicap to their best interests.

3. Classification. - **General***.* The first practical classification of Australian eucalypts was cortical, *i.e.,* founded on the appearance of the bark, and was adopted by the first settlers at Port Jackson in 1788, and such grouping has lasted to this day. The earliest botanist soon recognised that the bushmen could differentiate his trees in the field very much better than the systematist could in the herbarium, working on the morphology of his material. The principal groups of Eucalypts commercially are: - Ironbarks, gums, tallowwood, stringybarks, ashes, blackbutts, mahoganies, boxes, bloodwoods and peppermints.

These groups are satisfactory so far as they go, but they do not go far enough, for the trade difficulty is to discriminate between the **species** coming into the groups, since they are all classed as hardwoods. This term covers a multitude of timber characteristics, no regard being paid to such distinguishing features as colour, weight, durability, etc., all being placed in one class, simply because they possess one character in common, viz., hardness. Consequently, in buildings, wood pavings, and other constructions there is a medley of timbers.

Few, if any, timber yards or mills are prepared to sell a line of any particular timber such as mahogany, blackbutt, stringybark. They will execute an order for hardwood, and the purchaser has to make the selection from the consignment. A few varieties, such as spotted gum, tallowwood, ironbark (4 spp.) are, however, very often specified, and can be obtained true to name, and a few others outside eucalypts might be. mentioned, **i.e.***,* teak, myall, etc.

This state of affairs is a great disadvantage in many industries. Thus, in wood blocking, as many as half-a-dozen species of timber will be used each with its own special powers of atmospheric

and attrition resistance. Consequently, instead of having the evenness of surface during the life of a road which would obtain if wood of the same kind throughout were used, the variation in the breaking down of each kind produces an irregular surface for the traffic, and thus hastens the disintegration of the best wood, and. seriously impairs the life of the road.

The disadvantage can, of course, be overcome by stocking large quantities, from which can be selected the quantity and kind required.

There is perhaps something to be said on behalf of the mill owner, since his action is really governed by nature, which in this continent has not produced forests of specific trees, as is the case in the Northern Hemisphere. There are found entire forests of beech, oak, elm, pine, etc., but here species are met with growing indiscriminately.

In any classification of Australian timbers, Eucalyptus hardwoods are given pride of place, as they embrace by far the largest forest area, but the quantity and value of the ornamental timbers, other than hardwoods, are by no means to be despised. It is only recently, moreover, that it has been shewn that a number of our eucalyptus hardwoods may also be placed in the category of cabinet timbers.

IRONBARKS. The ironbarks are the most noted of the eucalypts for durability, hardness, weight, and closeness of texture. The species are limited in number and vary in quality of timber, their respective suitability for any particular work being a matter of choice with the various trades.

It may be mentioned that these timbers are restricted in their geographical distribution, the marketable varieties practically being found in New South Wales only. Two are recorded from Queensland, but these are not appreciated for their timbers. All the ironbarks have very hard, firm, thick, deeply furrowed bark, more or less impregnated with kino, this portion of the tree being much in demand by wheelwrights or blacksmiths for heating tires.

The weight or specific gravity of ironbarks is due to the great predominance of very thick walled wood fibres in the timber structure.

The principal Ironbarks are: -

(a) The broad-leaved Ironbark, **E. siderophloia***,* which is one of the best owing to its great strength and its superiority over iron and steel girders, inasmuch as it will not buckle when subjected to heat. This timber is used for beams, girders, and columns, wharf and bridge decking, heavy carriage work, etc.

(b) Grey Ironbark, **E. paniculata. Sm***.* This is another excellent timber, the tree being separated in the field from other Ironbarks by its hard, compact, corky bark-with less kino than obtains in the others-and its paniculate inflorescence. The wood is grey or chocolate in colour, very hard, compact, and, when interlocked, almost impossible to split. It is chiefly used for purposes similar to the Red Ironbark.

(c) Narrow-leaved Ironbark, **E. crebra. F. v. M***.* This tree has a much wider geographical range than the other species, being found in the coast district of New South Wales, in the coastal ranges, and almost to the interior. It is not considered of equal merit to its congeners.

The Red Flowering Ironbark, **E. sideroxylon** and the Citron Scented Ironbark, are not appreciated for their timber.

(iii.) GUMS. On a timber classification these are divided naturally into two classes:-**(a)** Pale coloured woods, and **(b)** Red coloured woods.

These constitute the largest section of the Eucalypts, and have the widest distribution, since representatives are found in all the States. They are recognised in the field broadly by their smooth white bark. Various common names have been bestowed upon the different species by the settlers, timber getters, and sawyers, the appellation having reference to individual peculiarities of the trees, such as (1) nature and colour of timber, (2) nature and colour of bark, (3) locality of growth, (4) chemical and physical properties of the several parts of the tree, or growth of the tree.

(a) **Pale Timbers**. Some of the best known trees throughout the world belong to this group, one name especially having gained more notoriety than the rest, viz., **E. globulus**, this being due to the wide distribution of its seed half a century ago.

As a timber it has been extensively exported from Tasmania for wharf piles, and decking, and such uses form about the limit of its employment today, as it is one of the most difficult to season. It is for this reason that **E. globulus** is no longer planted or sown for its timber.

Spotted Gum. E. maculata. Hook. One of the best known of this group of trees and very extensively used where resilience and lightness combined with strength are the desiderata, such as in coach building and other industries. It has recently been used in the furniture trade with much acceptance, as the colour somewhat resembles that of Oak (Quercus).

Care should be taken to see that all the sapwood is removed, as it is most liable to borer attacks, and this defect has often caused great trouble and expense in large buildings where the wood has been used for joists in error for tallow wood.
Giant Gum. E. regnans. F. v. M. One of the monarchs of the forests of Victoria and Tasmania, having a timber much approaching in texture and colour that of **E. Delegatensis**, but perhaps more fissile. It might be ranked as an ash, and is a splendid timber for work requiring similar qualities. It is a rapid grower and therefore one of the best for afforestation.

Salmon Gum. E. salmonophloia. F. v. M. Not a large tree, but the timber is hard, strong and durable, and extensively used in mines in West Australia. It has also been used in piles, and with great success in bridges and culverts. The name is derived from the colour of the bark.

Manna or Ribbony Gum. E. viminalis. Labill. This timber is regarded by some as poor in quality, but others again speak very highly of it.

Brown Gum. E. Muelleri. F. B. Moore. A very tall Tasmanian tree attaining a height of 200 ft., having a very pale pink or whitish timber, tough, of medium hardness, and might be classed as an ash, as it much resembles that group of trees.

Mountain Gum. E. goniocalyx. F. v. M. A forest tree producing one of the finest pale hardwoods in the world. It is close grained, hard, tough, interlocked, and useful in constructional works of all kinds, heavy carriage work, and similar structures.

York Gum. E. loxophleba. Benth. A good average forest tree of West Australia, yielding a very hard, durable, tough, red coloured timber, and one of the best for heavy carriage work, building construction, mining, etc.

A Blue Gum. E. Maideni. F. v. M. A fine forest tree of restricted area, yielding a superior pale-coloured hard timber, equal in qualities to **E. goniocalyx**.

(b) Red Coloured Timbers. In this section are to be found some of the finest timbers in Australia, and possibly in the world. The timbers here enumerated are all of excellent quality, and are highly valued both outside and in Australia for brightness of colour, easy working, and durability, while for general utility they are equal to any other timbers grown. They specially

appeal to the forester for re-afforestation, and few more magnificent and valuable forest trees could now be grown.

Murray Red Gum. E. rostrata. Schl. A beautiful forest tree found growing in the neighbourhood of all inland rivers and their tributaries and billabongs. It has deservedly received perhaps more attention at the hands of foresters than any of the other gums, and the red gum timber reserves of the river Murray are now famous. The timber is hard, durable, close, straight grained, but sometimes interlocked, dresses well and is very decorative from its red colour. It is one of our most valuable timbers for bridge decking, construction works, wood blocks, and heavy carriage work.

Sydney Blue Gum. E. saligna. Sm. Next to its variety Flooded Gum, it is one of the lightest in weight of the red gums, but it is probably more extensively used than any other in the group, being in specially great demand for wheelwrights' work, although its suitability for other forms of wood work have yet to be recognised. Its light red colour particularly adapts it for some forms of cabinet work. It is open in the grain, free working, rarely if ever affected with gum veins, and is a splendid timber for general purposes.

Forest Red Gum. E. tereticornis. Sm. One of the finest forest trees of Australia, yielding an excellent red wood. It very closely resembles the Murray red gum in texture, weight, and colour, and it is often difficult to differentiate their timber specimens. Forest red gum is a close, compact wood, although it dresses easily, but it is not a specially heavy wood. Its field of utilisation is worthy of great extension.

A Grey Gum. E. propinqua. H. D. et J. H.M. This is a superior red timber, but is rather restricted in its geographical distribution, being found only in the North coast district of New South Wales. It is worthy of re-afforestation, for it is a splendid forest tree. The timber is harder and heavier than its congener the blue gum, **E. saligna**, being of a closer texture, the fibres having thicker walls while there are fewer pores. It is a splendid timber, useful for many purposes, and will no doubt be much appreciated when better known.

Flooded Gum. E. saligna, var. pallidivalvis. B. R. T. B. et H. G. S. A well-known variety in the Sydney markets, used for many purposes, but not much valued for use as wood blocks. It is lighter in colour than its type, but more open in the grain, and considered less durable, still it is a useful timber and capable of being used in many ways.

Grey Gum. E. punctata. D. C. A well-known timber in the Sydney market, used extensively for railway sleepers. It is a particularly hard, durable, close grained, interlocked timber, and is often very difficult to distinguish from red ironbark.

South Australian Blue Gum. E. leucoxylon. F. v. M. A fine forest tree attaining a height of over 100 feet, often 50 or 60 feet without a branch. The timber is pale yellowish or pink in colour, hard, strong, and durable, and one of the best of South Australian timbers. It is used for railway sleepers, piles, jetty planking, naves and felloes, waggon shafts, telegraph poles, axe handles, and building construction.

Slaty Gum. E. Dawsoni. R. T. B. A very fine forest tree, with a tall straight white stem, and only a small head of branchlets and leaves. The timber is one of the finest, being hard, close grained, heavy, and equal in every way to ironbark, from which it is difficult to distinguish. It is a. splendid timber for heavy constructional works, and, in fact, can be used wherever great strength is required.

Morrell. E. longicornis.. F. v. M. Not a very large tree but has a very hard, heavy, close grained, interlocked red coloured timber, and one exhibiting great strength, especially suitable for heavy constructional work of all kinds.

Wandoo. E. redunca. Schau. A red coloured timber, lighter in weight than morrell, but otherwise possessing all the qualities of that timber for specific applications, suitable for naves, cart and buggy shafts, and railway truck construction.

(iv.) TALLOW-WOOD. A quite limited but excellent group of eucalyptus hardwoods, comes under the category of tallow-woods, viz., **E. microcorys** and **E. planchoniana**. The former is extensively used in heavy carriage and construction work, and is especially adapted for the latter, being a timber never attacked by the borers.

(v.) STRINGYBARKS. This group includes numerous species, but for some reason or other the timber has not received the appreciation it has deserved, probably due to the high value set upon ironbark and a few other excellent woods. Nevertheless these timbers are very valuable as hardwoods, and, as decorative timbers, their use within the last year or two has come as a revelation to the cabinet maker, and few more ornamental timbers have been introduced into the trade. The figure is often unique, and in colour the timber might readily pass as exotic satin wood. This figure must not be confounded with that produced by pronounced rays, such as occur in oaks, etc. (e.g **Quercus, Proteaceoe**, and **Casuarinae**), but it is due to the undulating disposition of the fibres, which is so frequently found in Australian woods.

The handicap of weight is overcome by using it as veneer on lighter timber, and some very handsome furniture made in this way has recently been exhibited in Melbourne and Adelaide. There is a great future in the cabinet-making trade for the figured eucalyptus hardwoods, especially stringybark and blackbutt.

The majority of these timbers are employed in house building, but a future awaits them in constructional works, and coach work, being durable, hard, fissile, interlocked, and less heavy than ironbark. They are easily distinguished in the bush by their stringy bark, which well describes the nature or character of the cortex.

The principal stringybarks, together with their uses and characters, are:-

White Stringybark. E. eugenioides. Sm. In New South Wales this is considered the best of the group, although not restricted to that State. The wood is close, straight grained, hard, durable, of a pale grey colour when fresh cut, and on exposure tones down to a rich oak tint. It is used as a general all round timber, but some specimens have recently been tested for their carving qualities, and in this field of applied art white stringybark is shewn to be one of the best, surpassing even English oak. As the more restricted species, such as ironbarks, are cut out, there can be no doubt that many new avenues of utilisation will be found for this splendid wood.

Yellow Stringybark. E. Muelleriana. A. W. H. One of the most prized stringybarks in Gippsland, Victoria, where it appears to be restricted in its geographical location. It is hard, close grained, with a yellowish tinge running through it.

A Stringybark. E. obliqua. L. Her. An historical tree, for this eucalypt was the first one to be described. It is found in Tasmania, South Australia, Victoria, New South Wales and probably in Queensland, The timber is extensively used in the first mentioned State and largely exported for use in general purposes, but it figures now in a new role, in the furniture trade, passing under the name of Tasmanian oak. In natural colour it certainly much resembles that timber, but of course has not the silver grain of oaks produced by the rays, which in the case of all eucalypts are microscopical, but beautiful figures are nevertheless frequently found, due, as stated above, to the peculiar twisting or undulating of the fibres.

Silver Top Stringybark. E. laevopinea. R.T.B. At present this very fine forest tree is only known from one district in New South Wales, but as it closely resembles other stringybarks in

morphological characters, it is very probably being passed over as another species, although bushmen were the first to show the field differences between it and its congeners, such as **E. macrorhyncha** and **E. eugenioides**.

A Stringybark. E. dextropinea. R. T. B. An average forest tree producing a fairly serviceable timber, but not so much appreciated as the previous species.

Red Stringybark. E. macrorhyncha. F. v. M. One of the most widely distributed of the stringybarks, being found in all the eastern states.

(vi.) ASHES. **Mountain Ash or Tasmanian Oak. E. Delegatensis. R. T. B.** When first described it was thought that the species was limited in its distribution, but it has since transpired that it occurs in Victoria and Tasmania as well as in New South Wales, and today is one of the best known and most easily procurable of all Australian timbers. It is a very fine wood and quite worthy of its local name Ash, for it possesses all the qualities of the **Fraxinus** (Ash) of other parts of the world, and for which it forms an excellent substitute, being light in colour and comparatively so in weight. The timber is straight-grained, free from knots or gum veins, obtainable in long lengths, and planes and dresses easily. It is, however, of no use for carpentry work in exposed positions, and although settlers have used it for fencing it soon rots away at the ground line.

Ash. E. fraxinoides. H. D. et J. H. M. A splendid timber possessing all the qualities of the best foreign ashes **(Fraxinus)** and for which it is a fine substitute. It is not found in the market, being rather restricted in its geographical distribution, but it is well worthy of cultivation. For casks it appears particularly suited, and its qualities will be more appreciated when the timber is better known.

Mountain Ash. E. Sieberiana. F. v. M. Placed here under the ashes, but only tentatively until the revised nomenclature now being prepared by the State Forestry

Department is published. This should never have been placed in the ash class as the timber is harder, closer grained, and different in colour to the species of that group. In Tasmania it is vernacularly known as "Ironbark."

Smooth Bark Mountain Ash. E. oreades R. T. B. This tree with its tall, white, smooth-barked stem is one of the features of the Blue Mountain gullies. It is occasionally found, however, in the levels and slopes above the gullies, as at Katoomba, but this is exceptional, for it is essentially a gully tree. The timber is not so white as the other ashes, nor quite so fissile, and is more liable to gum veins from which the others are specially exempt, otherwise it can be utilised in the same way as the other species of the group.

(vii.) BLACKBUTTS. Very few species are classed under this common name, and yet the two here mentioned are well known and appreciated in the trade for the quality of their timber.

E. pilularis is the blackbutt of the east coast, and its timber is highly valued for its durability in the soil. It is pale coloured, hard, close grained, with occasional narrow gum veins, by which it is generally identified. It is used principally in building construction, carriage works, bridges, wood blocks, and recently in cabinet work.

E. patens. Benth. A fair sized tree, with a light-coloured, tough, durable timber, suitable for carriage work and general building construction.

(viii.) MAHOGANIES. This group includes some well defined forest trees famous for their timbers, which are divided into two groups, pale and red.

The local application of the common name was due to the supposed resemblance of the red

mahogany to the commercial article, Honduras mahogany, familiar no doubt to many of the first settlers. The colour (red) is perhaps the only common character, the Australian wood being much heavier and harder and a deeper red, and subject to gum veins. However, it was used in the early days for cabinet work, but not to any great extent, the discovery of Red Cedar **(Cedrela Toona)** soon superseding it in this direction. The pale timber resembling its prototype in hardness and texture was called white mahogany.

(a) Pale. **"White Mahogany." E. acmenioides. Schau.** A good average forest tree yielding one of the best pale timbers. The timber is hard, close grained, and interlocked. It works well and is a very durable wood, being specially suited for sleepers, constructional works, bridging and heavy work requiring a strong white timber.

A **"White Mahogany." E. umbra. R. T. B.** A tree much resembling its congener **E. acmenioides**, but the timber is not so good in all round qualities.

(b) Red. **"Red Mahogany." E. resinifera. Sm.** It is a hard, close grained timber, darkening in colour with age, and is used for general purposes, but rarely used now for cabinet work. Its chief defect is the presence of borers, and it is not a lasting timber in closed damp positions, such as flooring joists. It is more durable in the light, and is extensively used for rusticated weather boards.

Jarrah. E. marginata. Sm. Although not known on the market as a red mahogany, yet it more resembles this class of timber than any other section. It is a splendid substitute for the Honduras mahogany, so largely used in other parts of the world in the cabinet trade. It is medium in weight, of a good fresh red colour, works up well and easily, takes a good polish, and is a beautiful timber for office fittings and furniture. It is, however, largely used for other purposes, such as constructional works and carriage work of all kinds.

(ix.) BOX TIMBERS. These are a well defined group of Eucalypts, with numerous species well distributed throughout the States. They may be divided into two classes of timber, pale and red. In other respects, such as in texture, grain, weight, durability, and hardness, there is a close resemblance. These timbers are particularly well adapted for heavy constructional work, carriage building, bridge decking, fencing, etc. Being interior species they are rarely found on the export trade market.

The principal boxes with Pale coloured timbers are:-

White box,. **E. albens, Miq.**; Apple-top box, **E. angophoroides, R. T. B.; Black box, E. Boormani, D. & J. H. M.**; Grey box, **E. hemiphloia, F. v M.**; Swamp box, **E. microtheca, F. v. M.** ; Coolabah, **E. Ravertiana, F.v. M.** ; Thozet's box, **E. Stowena**; Mallee box, **E. Woollsiana, R. T.B.**; Black or Flooded box, **E. bicolor, A. Cunn.**; **Lignum vitae, E. Fletcheri, R. T.B.**; Tuart, **E. gomphocephala, D. C**.; Fuzzy box, **E. conica, D. & J. H. M.**; Yellow box, **E. melliodora, A. Cunn**.

Red:-

Coast Red box, **E. Rudderi, J. H. M.**; A Red box, **E. polyanthema, Schauer**; South Coast Red box, **E. Bosistoana, F. v. M.**; Poplar-leaved box, **E. populifolia, Hook**; Ironbark box, **E. affinis, D. & J. H. M.**; A Red box, **E. pendula, A. Cunn**.

(x.) BLOODWOODS. These trees form a very distinct group from their congeners, their morphological characters being well defined, while their timbers are also **sui generis**. The species are not numerous, but they extend from Western Australia in a northerly direction round to the East coast as far South as the Victorian border. They can be detected in the field at once by the leaf venation alone. The timbers are hard, heavy, open in the grain, some having a large

figure, but are very prone to gum (kino) veins, hence their utilisation is limited. They are nevertheless strong and very durable in the ground, this quality being due probably to the tan in the kino. They are very suitable for railway sleepers, posts, bridge decking, etc.

The principal species are :-**E. corymbosa, E. calophylla** (the red gum of Western Australia), **E. eximia**, yellow bloodwood, **E. intermedia, E. terminalis, E. trachyphloia**.

(xi.) PEPPERMINTS. These do not comprise a numerous section of eucalyptus trees. They derived their name originally, from the presence of the peppermint odour in the leaves, attention to which was first drawn by the medical officers of the First Fleet. The constituent giving rise to this odour has since been isolated and named Piperitone, and promises to be of considerable value in pharmacy.

The timbers are not generally found on the market, although in the country districts where they occur they are used for many purposes, and some have a reputation for durability in the ground. In recent times the name unfortunately is being applied to trees which have a bark similar. to the original peppermint tree, **E. piperita**, but have no trace of Piperitone in the leaves.

The Chemical Products of Australian Eucalypts

1. General. - The important Australian genus, Eucalyptus, is remarkable for the number and diversity of its chemical constituents. It might perhaps appear from a cursory glance that these were distributed throughout the several groups in an irregular manner, but research has shown that this is not so, for a most orderly arrangement is traceable through the various members and groups of the genus, a peculiarity which suggests a predominating influence of evolutionary conditions.

* Contributed by Henry G. Smith, Esquire, F.C.S., Assistant Curator and Economic Chemist, Technological Museum, Sydney.

2. Inorganic Influences. - A distinctive selection in location by very many species, growing under natural conditions, has been recognised. Some prefer a siliceous soil, while others select a basic one, and numerous examples of eucalyptus species approaching a common boundary, yet not intermingling, are known. This peculiarity is well demonstrated by the species growing between Sydney and Penrith, and upon the Blue Mountains. The chief controlling factors governing the geographical distribution of most eucalypts seem to be climate, altitude, and soil, and the adaptation to certain localities, shewn by various species, is directly traceable to chemical influences, and more particularly to available inorganic constituents. It is seldom that species are found growing satisfactorily in a situation unconformable with their usual requirements.

The great differences in size between members of the various groups is also traceable largely to chemical influences, and the largest trees growing in Eastern Australia belong to a group, the species of which have much in common, both botanically and chemically. Four of these may be mentioned in illustration, viz., **E. regnans** ("Giant Gum"); **E. Delegatensis** ("Gum-topped Stringybark"); **E. obliqua** ("Stringybark"); **E. pilularis** ("Blackbutt"); the first three being common to both Australia and Tasmania. Eucalyptus trees that attain a great size usually grow in soils comparatively poor in mineral constituents, and trees of large dimension, so placed, do not store mineral matter in their timbers, except in very small amounts. **E. regnans**, for instance, sometimes exceeds 70 feet in circumference, and reaches a height of over 300 feet, yet it secretes only about 0.05 per cent. of inorganic chemical constituents in its timber (calculated on the anhydrous wood). The other species mentioned above shew the same peculiarity; **E. Delegatensis** about 0.04 per cent.; **E. obliqua** about 0.03 per cent.; and **E. pilularis** about 0.05

per cent. Although the amount of ash constituents in the woody portions of these and allied species is so small, yet a much larger quantity is present in the leaves, buds, petioles, seed-cases and seeds from the same tree. The leaves of **E. pilularis**, for instance, contain about 2.9 per cent. of ash ; the buds with petioles about 3.8 per cent.; the seed-cases or fruits about 2.9 per cent., and the seeds 1 per cent. The inorganic material in these portions of the tree would obviously be available for repeated use, but not so if deposited in corresponding amount in the timber.

A striking peculiarity in the eucalypts is the relative constancy of the element manganese in the ash of related species. The mean results in the case of the four species above mentioned shew that the manganese present in their timbers represents only one part in about one million parts of anhydrous timber, being practically the same in each. In the five species of "Ironbarks" the manganese is about one part in sixty thousand parts of anhydrous timber.

The actual part manganese plays in plant metabolism is not well known, although during late years considerable work has been undertaken in regard to its relation to plants generally. It seems remarkable that such relative constancy in the amount of manganese should be shown with members of particular groups of eucalypts, especially as it occurs in such exceedingly small quantities. Although the ash contents in the timbers of the "Ironbarks" vary in amount among themselves, yet the manganese is relatively a constant quantity, and is in amount about five times that found in the ash of timbers belonging to the group of which **E. regnans** may be considered the type.

Another peculiarity shewn by the inorganic constituents of the several groups is the changing amounts of calcium and magnesium. In the ashes of the timbers of the typical "Boxes".-"White Box" **E. albens**, for instance-the lime (Ca O) exceeds 50 per cent., while the magnesia (Mg O), is only about 2 per cent. In the ashes of the "Ironbarks" the lime is about 30 per cent., and the magnesia about 7 per cent. In the inorganic portion of the timber of **E. regnans**, the lime is only about 16 per cent., while the magnesia has increased to about 22 per cent. The reason for this is apparent, because in those species in which lime is the chief constituent, oxalic acid is a characteristic product of metabolism, and Nature usually disposes of an excess of this substance in plants by combining it with calcium to form the insoluble calcium oxalate. In some eucalypts the calcium oxalate is present in such abundance that at times as much as one-sixth of the entire air-dried bark consists of crystallised calcium oxalate. It is not difficult to separate these crystals as such, and if the smooth barks of certain species are finely powdered, boiled in water until the crystals float out of the cells, they will collect on the top of the water. The crystals from the barks of all the species which contain them are similar in shape, and have the peculiarity of often forming geniculate twins. The crystals are about 0.017 mm. in length and about 0.007 mm. in breadth; they make excellent objects for observation under the microscope.

With the big trees belonging to other groups, oxalic acid is not formed to the same extent, consequently calcium is not in such request, and it is in these trees that the magnesium is at times in excess. The amount of each element is, however, small, the lime in **E. regnans**, for instance, representing about one 15,000th part of the weight of the moisture-free timber, and the magnesia about one 10,000th part. Oxalic' acid might be obtained economically from certain eucalypts, because the tannin in those barks which contain it is of very good quality for tanning purposes. The cost of collection and preparation would be borne by the tannin extract so prepared, and the oxalic acid obtained as a by-product. **E. salubris** of West Australia is a species which might be so treated. Already large quantities of the bark of an allied species, the "Mallet," **E. occidentalis**, have been used for tanning purposes, and a considerable trade has been done with it in Western Australia.

3. Eucalyptus Tannins. - It would be well perhaps at this stage to refer generally to the tannins of the eucalypts because of the great diversity in the properties of these substances as derived

from members of the several groups. The astringent exudations, or kinos, may be taken as illustrating the particular tannin present in the tree, and this is often associated with well defined chemical bodies such as aromadendrin and eudesmin.

All the exudations of the earlier members of the genus, as well as those of the closely related genus Angophora, contain the crystallisable body aromadendrin **alone**, eudesmin not being present in any degree. As the genus evolved, eudesmin, which is a beautifully crystallised body, makes its appearance, and continues to increase in amount until it reaches a maximum in the exudations of the typical "Boxes," (**E. hemiphloia, E. albens, etc.**), where it occurs to the extent of about 10 per cent. Although the quantity of eudesmin increases so greatly, yet the aromadendrin has not been entirely eliminated, so that while aromadendrin occurs without eudesmin in some eucalyptus kinos, the reverse is not the case. These two substances can be readily separated from each other, and they give entirely reverse colour reactions with strong sulphuric and nitric acids. As the genus further evolved both these bodies ceased to be formed, and the exudations of the "Stringybarks," the "Peppermints," the "Ashes," and in fact all the more recent groups of the genus do not contain either body. Economically this is of importance because the tannins in those species which contain eudesmin and aromadendrin in their kinos can be utilised for tanning purposes, if sufficiently abundant. Their affinity for hide substance is excellent, but this is not the case with the tannins in which these bodies are absent. Although the kinos of the "Stringybarks," and the "Peppermints," appear to the taste the most astringent of all, and the potassium permanganate test certainly supports this, yet the affinity of these tannins for hide substance is very low indeed, and they are therefore unsuitable as tanning agents.

This peculiarity also accounts for the "sluggishness" in tanning properties of the barks of the "Ironbarks," **E. sideroxylon** for example. But while the tannin in the exudations of the "Ironbarks "is similar to that in the "Stringybarks," in the former it is combined with a member of the sugar group, so that these exudations consist of a tannin glucoside. This glucoside has been named "Emphloin," and it differs from other eucalyptus exudations in being insoluble in alcohol, although soluble in water. For a long time this substance was thought to be a gum, but gum as such is not present in the eucalypts.

It might be expected that such a diversity in chemical properties would influence the employment of these eucalyptus kinos commercially, and such is the case. Besides being utilised for tanning purposes astringent exudations are employed in pharmacy for the preparation of tincture of kino, but one great objection to them generally has been that after some time the tinctures form a jelly, and thus become spoiled. Eucalyptus kinos have been employed for this purpose, but at times with indifferent success. The reason for this is now easily explained. The kinos of the "Ironbarks" do not go into solution in alcohol, while those of the "Stringybarks" and "Peppermints" quickly form jellies; nevertheless certain very astringent eucalyptus kinos, which are readily soluble in alcohol, do not form jellies, no matter how long the tinctures may be kept. Pharmacists, therefore, need not be troubled further with gelatinized tincture of kino if the proper eucalyptus kinos are used in its manufacture. The exudation of the "Red Gum" of West Australia, **E. calophylla** is, for many reasons, the best of all for this purpose, and the writer has a sample of the tincture of the kino of this species which was prepared over twenty years ago, and is as fluid to-day as it was when first made. The exudation of the "Red Gum" of Eastern Australia, **E. rostrata**, is not so good in many respects, although it makes a very fair tincture, and is now used for this purpose.

4. Eucalyptus Essential Oils. - The relative constancy in chemical products derived from a particular species of eucalyptus is a characteristic feature, and as particular chemical constituents can be determined with great accuracy, it follows that considerable assistance can be rendered to botanical diagnosis by this chemical evidence, irrespective of the economic aspect. It is sometimes difficult to place definitely a doubtful species of eucalyptus without a determination of its chemical characteristics. That the changes which have taken place in the genus, both botanically and chemically, have been contemporaneous is shown from the study of the leaf venations in connection with that of the essential oil products. In the earlier members of

the genus, the "Bloodwoods" for instance, the venation of the mature lanceolate leaves resembles closely the markings of a feather, the numerous veins being quite obtuse, the midrib thick, and the marginal vein close to the edge of the leaf. The essential oil distilled from species, the leaves of which have this venation, consists largely of the terpene pinene, a substance which has ten carbon atoms and sixteen hydrogen atoms in the molecule. None of the oils from this group is at present of economic value, although a very good turpentine (pinene) is obtainable from species occurring later in the genus. As the genus evolved, the leaf venation became less obtuse, and more open, the marginal vein further removed from the edge, and the midrib less thick. The oil from trees with this leaf venation still has pinene as the chief-terpene, but the oxygen-bearing constituent, eucalyptol or cineol ($C_{10}H_{18}0$) occurs in quantity. Eucalyptus oils of this class are now largely in demand for pharmaceutical purposes, and also for the manufacture of pure eucalyptol, so that economically this group is of considerable importance. Those species which occupy the more recent end of the genus, and occur so plentifully on the highlands of the eastern portion of Australia and Tasmania, have again a different leaf venation to those of the other two classes. The midrib is thin, the veins very acute and open, and the marginal vein removed from the edge of the leaf to so great a distance that often a second one has formed. The oil distilled from the leaves of these species consists largely of the terpene phellandrene, a substance also containing ten carbon and sixteen hydrogen atoms, but these are arranged differently in the molecule from those in pinene. This terpene is absent from the oils of the first group, and also from those of distinctive members of the second class. The yield of oil from some species belonging to the third class is very considerable, and it can be cheaply produced. Large quantities are used industrially in the separation, by a flotation process, of metallic sulphides, such as those of lead, zinc, copper, molybdenum, etc.

These cheaper phellandrene eucalyptus oils, moreover, act more satisfactorily in the flotation process than the more expensive eucalyptus oils. The product of the "Broad-leaf Peppermint," **E. dives**, appears to be the best of all essential oils for mineral separation, and a considerable industry should be established in Eastern Australia in the preparation of the essential oil from this and similar species. Many tons of oil per month are at present being distilled in New South Wales and Victoria for flotation work, and systematic effort should largely increase this output. The yield of oil from *E. dives* is about 3 per cent., and the species has a most extensive range in the highlands of New South Wales and Victoria.

Representative species of the first group are not found in Victoria, except at one locality on the border of New South Wales, and are quite absent in Tasmania. The members of the second group have a more extensive range and occur in all the States, including Tasmania, while those of the third group are found mostly in Eastern Australia and Tasmania. There is, however, no well-marked line of demarcation separating one group from the other, and chemically the constituents gradually increase in amount until a maximum is reached in one or more species of the group.

Although some hundreds of distinct species of eucalyptus occur in Australia, yet the number which can be utilised commercially for oil distillation does not exceed perhaps 10 per cent. The two chief factors which govern production are yield of oil and composition. The yields vary considerably, ranging from about 4 per cent. to practically nothing, and it is a remarkable fact that each species not only gives an oil comparatively constant in composition, but secretes the oil in practically a uniform manner. These characteristics, moreover, hold throughout almost the entire range of the species, the known exceptions being very few. The quantity of oil diminishes somewhat during the winter, increasing again in the spring and summer months. Species which yield oils suitable for pharmaceutical purposes vary in amount from about 2 per cent. downwards, a very large number yielding from half to three-quarters per cent. It is of course evident that the least prolific species cannot compete commercially with those which give a greater amount of oil, if the products are of equal quality; but when the oil constituents of the less prolific varieties are of considerable value, such as those used for perfumery purposes, **i.e.**, the alcohol geraniol, and its

ester geranyl-acetate, distilled from the leaves of **Eucalyptus Macarthuri***;* or the aldehyde citronellal from **E. citriodora***;* or the aldehyde citral from **E. Staigeriana***,* the extra value of the oil makes up for the smaller yield.

Pharmaceutical eucalyptus oils, when rectified, are either colourless or tinged yellow. This peculiarity appears to be due to the action of the two phenols peculiar to eucalyptus oils; one of these has been named tasmanol, because it occurs more frequently in the oils of the Tasmanian species. It is a liquid phenol, and in the structure of its molecule differs from the other phenol which is crystallisable. This has not yet been named, but it evidently changes to form a coloured substance with a quinone structure, which tasmanol cannot do as it contains a methoxy group.

Another characteristic of the colourless oils which contain the terpene phellandrene, is that often a constituent is present which has a strong peppermint odour, and this is particularly noticeable in the oils of the "Peppermint" group. This constituent is a ketone, and has been named piperitone; it combines with sodium bisulphite, and can therefore be obtained in a pure condition.

The yellow oils, on the other hand, often contain a characteristic constituent known as aromadendral. This is an aromatic aldehyde, and is particularly associated with the oils of the "Boxes" and of the "Mallees," and it can also be prepared in a pure condition. These two bodies do not appear to occur together in the oil of the same species.

Several other constituents have already been isolated from certain eucalyptus oils, but these at present do not appear to have distinctive group characteristics, or to be of economic value; they are thus only of scientific interest. Among these may be mentioned the low boiling alcohols and aldehydes; the low boiling ester butyl-butyrate; the solid crystalline substance eudesmol; the two solid paraffins-one having a melting point 64^0 C., the other melting at 55-56^0 C.; the sesquiterpenes ($O_{15}H_{24}$); and the hydrocarbon cymene ($C_{10}H_{14}$).

The terpene limonene ($C_{10}H_{16}$) which occurs in the oil of **E. Staigeriana** may eventually become of economic importance, as it is associated with the aldehyde citral; this eucalyptus oil is thus in agreement in chief constituents with lemon oil, and could be equally well used for flavouring purposes, besides being more cheaply prepared. The optical rotation of the eucalyptus limonene is, however, to the left, while that in lemon oil rotates the ray to the right. This peculiarity is known as stereo-isomerism, and is physical rather than chemical.

5. Rubber and Wax. - The very young leaves and shoots of the earlier species of the genus, the "Bloodwood" group particularly, are coated with an elastic substance which on investigation was found to be a rubber of very good quality, but as it occurs on the exterior of the leaves it is susceptible to alteration under the influences of sun and air, so that it is not found on the older leaves. It has no economic value but is of particular scientific interest, as it does not occur on the leaves of the members of the other groups, and apparently was one of the first chemical constituents to be discarded by nature in the process of evolution.

Another constituent which is found coating the leaves of some species is a vegetable wax, and the pulverulent appearance of their young leaves is due to this substance. It can be easily removed but is not promising economically, as it has a somewhat low melting point, 60^0 C., and vegetable waxes are known which melt at a much higher temperature.

6. Eucalyptus Dyes. - The leaves of some species of eucalyptus are quite yellow when dry. This peculiarity is due to the presence of a dye-material which has been named myrticolorin. This substance is a glucoside of quercetin, and is thus closely allied to quercitron, a material that has long been used for dyeing purposes. Myrticolorin is easily separated as a definite substance by the following process :-The leaves are finely ground, boiled in water, filtered boiling hot, the filtrate allowed to cool when the myrticolorin crystallises out, the tannins and salts remaining in

solution. It is then filtered cold, washed and dried. As much as 8 ½ pounds of myrticolorin from each 100 pounds of ground leaves were obtained from the leaves of the "Red Stringybark, **Eucalyptus macrorhyncha**. It dyes various colours with different mordants; yellow with aluminium, and khaki with potassium bichromate. As the dye is fast to light and to milling it might be utilised for khaki and other dyeing, as it is quite suitable for the purpose, and at present is going to waste.

Some of the eucalyptus exudations could also be utilised for dyeing purposes, and possibly with advantage. It is very necessary, however, that research work be under taken to decide this point, as well as to determine the value of other probable Australian vegetable dyes.

7. Carbohydrate. - Chemical constituents other than those enumerated above are known to occur in the eucalypts, but I shall refer here to one only, viz., the carbohydrate raffinose, which was discovered by Johnston in 1843 in eucalyptus manna.

Most persons in Australia, at all events, have heard of eucalyptus manna, the white sweetish material found at times on the ground beneath certain species, **E. viminalis** particularly. Raffinose is the chief constituent in this substance, but is somewhat sparsely distributed in nature; it has been found in sugar beet and also in cotton seed. When the molecule of raffinose is suitably broken down, the sugars formed are dextrose, laevulose, and galactose, so that raffinose is a more complex substance than cane sugar.

Two distinct organic chemical substances are thus separately circulating, and are obtained as exudations from some eucalyptus species, viz, an astringent one peculiar to the group, and manna. This sweetish exudation is not peculiar to the leaves of the tree, but is sometimes found exuding from the bark, and a fairly good specimen is in the Sydney Technological Museum, showing the manna attached to the bark from which it was exuding, together with some of the pure kino collected at the same time and from the same tree. The species was **E. punctata**.

8. Economic Advantages of Eucalyptus Cultivation. - In conclusion, reference may be made to the economic advantage to be derived from the cultivation of those eucalyptus species which show the most promising results for the production of chemical products useful for industrial purposes.

It is, perhaps, difficult to impress the ordinary Australian with the advantages to be derived from the cultivation of the "Gum Trees," yet this will eventually be done, and already the cultivation of one species has been commenced in Victoria. If thousands of acres were planted with the right species for the production of the required products, then priority in supply to the world's markets would be secured. It seems certain that particular species of eucalyptus will eventually be cultivated for the chemical products they afford and if this is not done in Australia, then the people in other countries will reap the advantage to be gained from such cultivation.
